The Spokesman

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A.S.T.M. D217, Specs. AN-G-15a and AN-G-25

Motor driven and automatically controlled by a pre-setting counter. This machine is used to prepare samples for standard penetration tests. Reduces personal operation to a minimum on routine tests. Provision for a thermometer enables proper testing at 77° F. and the counter can be set to stop automatically at 60 strokes for A.S.T.M. D217.

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PRECISION Motor-Matic Grease Working Machines (ASTM D217, Specs. AN-G-15a and AN-G-25)

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Precision DUAL MOTOR–MATIC GREASE WORKING MACHINE

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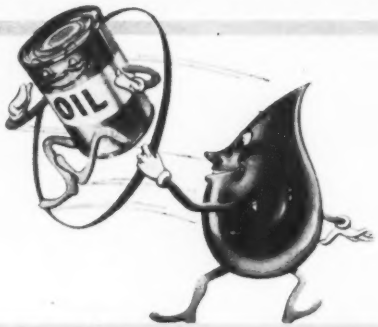

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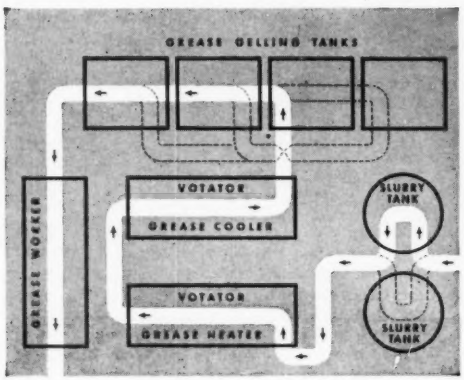

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ABOUT THE COVER . . .

The laboratory grease-making apparatus recently developed by the Mallinckrodt Chemical Works presents a unique and promising approach to the subject of experimental grease preparation. Designed to handle one-half to one pound samples under accurately controlled conditions, this device has proven to be of great value in basic research and the practical solution of manufacturing problems. Among its advantages are semi-automatic operation, simplicity, extreme versatility and exact reproduction of results. From one to six batches may be made at a time, with the maximum convenience and economy of materials.

Greases are prepared in 600 ml. beakers heated electrically through a circulating oil bath. Inconsistencies due to local overheating are thus completely avoided. Reproducible temperature control is provided by a Variac transformer which allows a wide range of heating rates and final grease temperatures.

The oil bath may be used as a cooling chamber for the greases and in this way conditions can be controlled as desired. The samples can also be conveniently removed for oven-cooling. The insulated bath contains a copper water coil for rapid return to room temperature between runs.

The greases are efficiently stirred by twin propellers operating at 700 rpm. The stirrer shafts are equipped with baffles which hold the grease in the beaker and aid in maintaining good heat transfer.

Experience has shown that this apparatus will form a series of greases of given composition which are so similar in properties that they cannot be differentiated by the standard tests. By eliminating the variables of preparation, the apparatus also provides a means of accurately comparing the behavior of different soaps and oils. Flexibility of operation makes possible the study of grease-making under many different conditions and the duplication of actual plant results when sufficient information is available.

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President's page

by B. G. Symon, President, N.L.G.I.

The day I write this, it is not difficult to conjure up a picture of Christmas. There's a gray sky, the air is raw and it feels like snow. On the way to work this morning I passed a store window full of toys, with a huge figure of Santa Claus in the background. A few minutes ago one of the young fellows in my office was winding up a mechanical toy he had bought for his three-year-old son, and several other chaps gathered around to watch it cut capers on a desk top.

So it's not difficult to picture Christmas — trees gaily lighted, stockings hanging from the fireplace mantel, groups of carolers singing on Christmas Eve, bright youngsters' faces on Christmas morning, and all the other familiar sights and sounds that are part of this joyous holiday.

I sincerely hope that Christmas will be at its traditional best for each member of the N.L.G.I. this year. May it find you in good health. May it see you together with all members of your family, having the fun that only families can have. May it bring you good food and laughter . . . May you share in the happy spirit of giving and store up fine memories for the future.

To Arthur Daniel, I want to extend my best wishes for the success of your term in office.

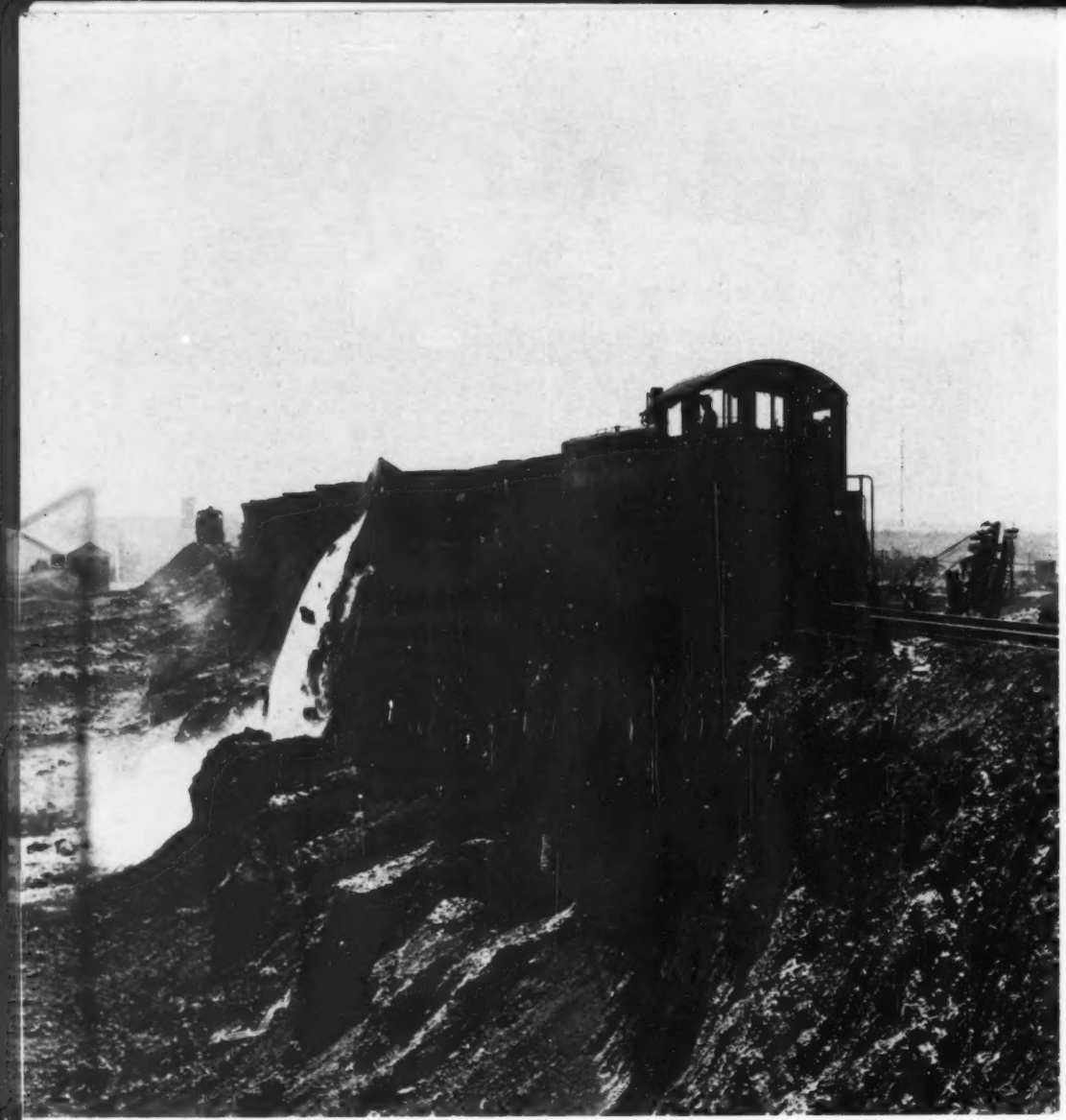
To members of the Board of Directors, thank you for the cooperation you have given me. It has been a pleasure working with and for you.

To A. J. Daniel, E. V. Moncrieff, W. W. Albright, W. H. Saunders, T. G. Roehner and H. L. Hemmingway, and other committee chairmen and members, my appreciation for your splendid accomplishments during the past year.

To Harry Bennetts, my thanks for your patience in waiting for some of these columns. I hope I haven't played havoc with too many deadlines.

It has been a great honor to head the National Lubricating Grease Institute. I feel particularly fortunate because the job gave me an opportunity to renew many old friendships and to make many new ones. Perhaps the thing that impressed me most during the year was the cooperative spirit of the members. More men than I can possibly list here have put in a considerable amount of time and effort on projects for the good of the Institute and the industry, with little or no glory for themselves. With this spirit in the organization, the N.L.G.I. is certain to prosper.

Thanks again to everyone. A very merry Christmas to you and a happy New Year.



The lubricant selected for use in slag cars and hot metal ladle cars must withstand heat and pressure.

Mr. Hamilton's article gives to "Spokesman" readers a subject, in an extremely interesting presentation, that cannot be emphasized too much.

A Chat With A Steel Mill Lubricating Engineer

by W. E. Hamilton, Lubrication Engineer
Tennessee Coal, Iron and Railroad Company

TRAPPED

The Chairman of the Committee on "Get Some More Stuff Boys, the Circulation's Falling Off", requested that I submit a paper on some phase or phases of steel mill lubrication and in a weak and unguarded moment I said, "yes."

WARNING

Let me say in the beginning that by reading this article, you will gain no deep and profound formula or fundamentals regarding lubrication. I came to the conclusion long ago that too many technical articles seem to be written for the express purpose of displaying the vast knowledge and brilliance of the writer rather than of conveying some useful information to the reader.

RELAX

So, let's keep it informal, shall we? For once in your life here's an article that you can read without the use of a slide rule, calculus equations and an interpreter.

A BROAD FIELD

Now that we have agreed on that, what shall we talk about? Lubrication of a steel mill is a rather broad subject. A fully integrated steel-making unit includes ore mines, coal mines, limestone and dolomite quarries and transportation facilities as well as blast furnaces, open hearths, diversified rolling mills and all the related operations. Birmingham, Alabama, is the only district in the world where all the major ingredients necessary for the making of steel are found in abundance in the same locality, and have been put to use in its manufacture.

One can hardly visualize the vast number of wheels, bearings, journals, gears, pinions, cylinders and multiple moving parts involved in the process of steel making.

Since it will be impossible to discuss all of these operations in this paper, this might be a good time to discuss some of the things that worry lubrication engineers and yet are rarely talked about.

SPECIFICATIONS

On all of our mills employing oil circulating systems for bearing or gear lubrication, the company furnishing the equipment sets up specifications on the lubricant. This is apparently done without any thought as to what lubricants the purchaser is already stocking and using. And very often these demands on the part of the manufacturer work a hardship on both the mill operator and the oil companies. We have contended for some time that too fine a line is drawn as far as specifications are concerned.

As an example, let's take a look at the lubrication of some of our strip mills.

Our company is, at present, operating the following strip mills:

1—Hot strip mill consisting of 2 roughing stands, a scale breaker and 6 finishing stands.

2—5 stand tandem 4 high cold reduction mills.

1—4 stand tandem 4 high cold reduction mill.

5—2 stand tandem 4 high temper mills.

1—4 high temper mill (sheet mill)

All of these mills are equipped with sleeve type, oil lubricated bearings. The oil is circulated through the bearings by means of the conventional circulating systems consisting of settling tanks, pumps, pressure tanks, coolers and filters.

Now it is my humble and unsought opinion that all of these mills could have been designed to utilize an oil of the same viscosity. But, as a matter of fact, no two mills carried the same specifications as to viscosity of the circulating oils. Adhering strictly to these recommendations would have necessitated stocking a half dozen different oils for these operations. However, by giving a little and taking a little, we have narrowed the field down to three types of circulating oils for these applications, namely 2450, 1750 and 1200 S.S.U. viscosity oils. This is still two, too many. Anyone with the responsibility of buying, storing and distributing lubricants can appreciate the tremendous advantage in minimum inventories. And, I say again, these mills could have been designed to use the same circulating oil. Here's why: On one of our mills we use 2450 second viscosity oil. On another we use 1750 second viscosity oil. We attempt to maintain an operating temperature of 100°F. on these systems. As every operator knows, this is quite impossible. Suppose that the temperature of this oil increases to 110°F. Could happen in the best regulated families or oil basements. What does this 10° rise in temperature do to our oil? It changes it from a 2450 second viscosity oil to a 1750 second viscosity oil. What happens on the mill? Like 'ole man river, it just keeps rolling along. Now suppose on our 1750 second viscosity oil, the operating temperature decreases about 8°. We are back to 2450 second viscosity oil again! Are you on my side yet? Anyway, we believe that with a little cooperation and exchange of information the number of lubricants could be drastically reduced with no sacrifice in efficiency of operation.

GREASES

Come to think of it, "The Institute Spokesman" is primarily interested in greases—so . . . let's talk about greases. From interviewing representatives of various petroleum concerns regarding greases the writer gets the idea that the industry seems to be in a "keep up with the Jones's" cycle at the present time. The manufacturer of equipment increases his demands as to what a grease must do, the petroleum industry attempts to meet these demands and the helpless lubrication engineer, caught in the middle, gets the idea that both parties

have adopted the slogan "If you can't convince 'em, confuse 'em."

For example, grease manufacturer "A" will "improve" his product by adding an "oxidation inhibitor" "B" company goes one step further and not only adds the "oxidation inhibitor" but also adds a "rust inhibitor". "C" hears about the revolution and joins in by adding all of these "improvers" plus a mystery addition of his own. And so the cycle goes, the grease manufacturer turning his refinery upside down attempting to meet specifications that were set up by someone who probably isn't any too familiar with operating conditions. He knows he has a grease that will do the job but it just doesn't meet specifications.

As an illustration of my point, on my desk at the present are the manufacturer's recommendations as to the type of grease to be used on a piece of equipment being installed in one of our works. This manufacturer insists that the grease shall possess extreme pressure (E.P.) characteristics and shall have a dropping point of over 500°F. If we were attempting to lubricate the hinges of the gates of the nether regions, I could understand the need for such specifications. But, when the chances are about a thousand to one that the bearings of this equipment will ever operate over 175°F., these instructions just do not make sense. In a few applications, a grease with a melting point of 500° would be desirable, but for general mill lubrication, specifications such as these only start an unnecessary cycle of "out-doing the Jones's". If raising the melting point improved the quality of a grease then this trend would justify itself. I'll be the first to admit that greases should be improved to meet more stringent demands of modern design, but I'm afraid we are hunting rabbits with a cannon.

The equipment manufacturer sets up certain demands for a lubricant, the grease manufacturer goes to a lot of expense producing a product, not to do the job, but to meet specifications, and who do you think absorbs this extra and sometimes unnecessary expense? RIGHT! In the middle again. Now don't you people in the grease business start throwing stones at the equipment manufacturer too soon! Where do you suppose he got the idea for these specifications? Couldn't possibly be from someone in the petroleum industry with a grease that has a melting point of over 500°, could it?

ONE FOR ALL

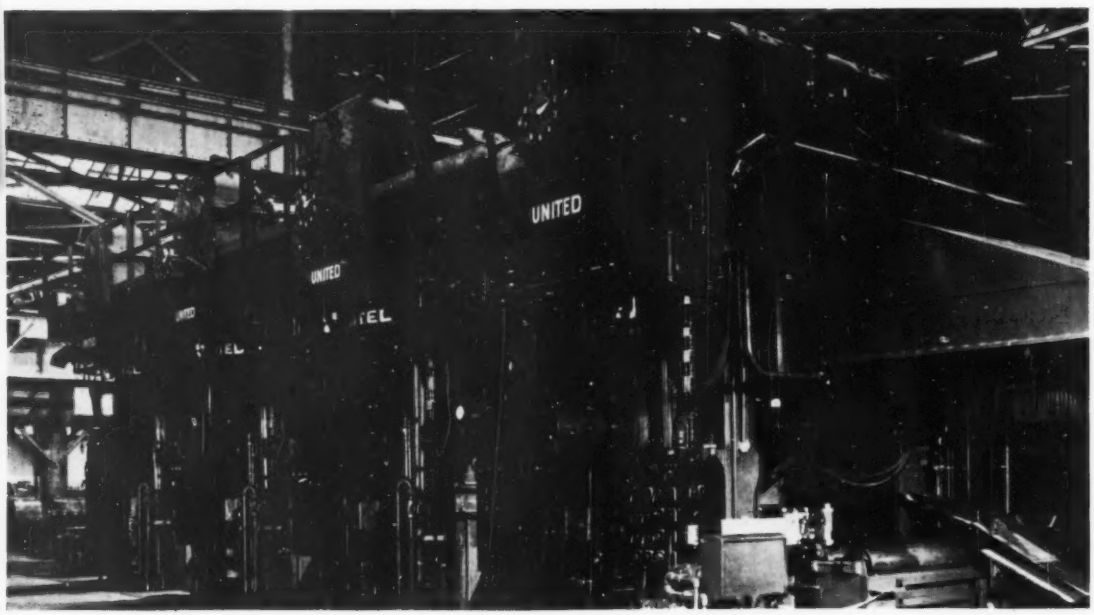
There has been considerable talk by the petroleum people about an "all-purpose" grease for steel mill lubrication. That makes awfully good listening for a lubrication engineer, but at the same time comes the realization that that's a man-sized order. To be an all-purpose lubricant, it naturally would be required to perform satisfactorily in the toughest, heaviest, hottest and fastest bearing as well as in normal operating applications. Could such a grease be made at a price that wouldn't increase the over-all grease cost to such a point as to have purchasing agents wake up screaming?

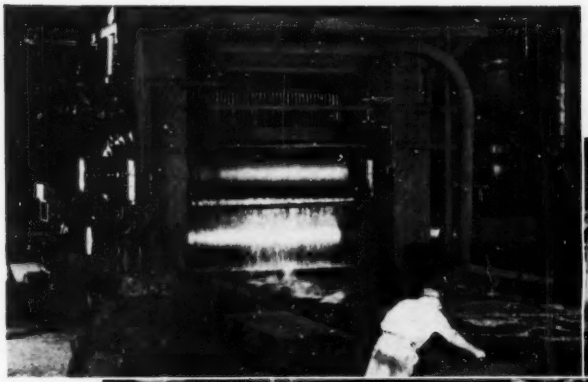
However, a one-grease steel mill is a beautiful thought, so let's keep thinking. I'll even settle for two greases and if you twist my arm, three.

VARIED APPLICATIONS

What are some of the jobs an all-purpose grease would be required to do in a steel mill? In my opinion there is no

The back-up rolls of this 4 Stand Cold Reduction Mill are equipped with oil type bearings. The work rolls are equipped with anti-friction bearing lubricated with automatic greasing system.





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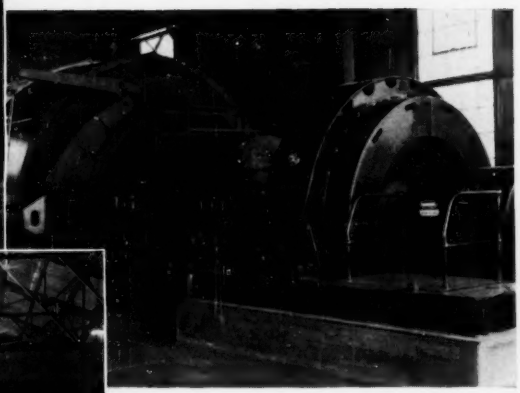
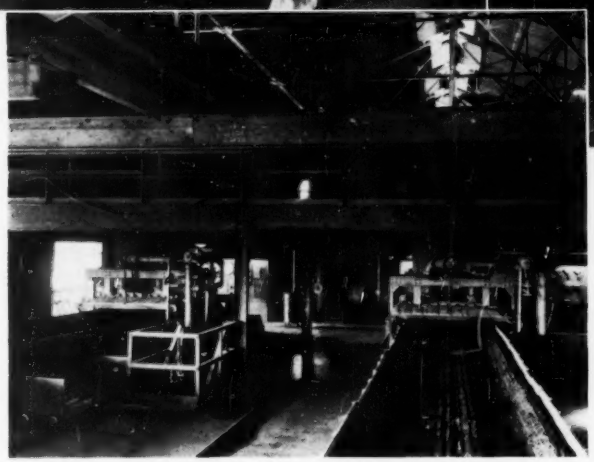


2.

1. The work roll bearings and table bearings of this Plate Mill are constantly subjected to water, heat, pressure and mill scale.

2. This view illustrates that hap-hazard lubrication of mine equipment is a thing of the past. This motor, gear reduction and drum requires the highest quality lubricants.



3.

3. Picture showing two sintering lines. The view of the machine on the left shows rolls that must be lubricated with a grease that will stay in the bearing at high temperatures. Note section of bed on floor. The sinter shown at right is at high temperature.

place where more is demanded of a lubricant than in the thousands of applications to be found from the mines to the rolling mills.

MINE LUBRICATION

In the "good old days" about all that was needed for mine lubrication was cup grease and black oil. Mine lubrication presents a vastly different picture at the present time. With mechanized mining have come intricate and involved mine machines that do everything but build a fire in the furnace. This type of equipment calls for the best hydraulic oils, excellent gear lubricants and high grade greases. The mine cars can no longer be lubricated by squirting a stream of black oil somewhere in the region of the axle. The modern cars with antifriction wheel bearings must be lubricated with the best greases obtainable. The grease must be stable and maintain its lubricity for long periods of time. It is very difficult to maintain a regular greasing schedule on all mine cars. As a matter of fact, it's impossible. Due to operating schedule, a car sometimes misses one, two or three regularly scheduled greasing periods. In some cases, it's possible that these bearings will come in contact with water. Add to this the fact that coal dust is a factor to be considered and you have some excellent reasons why greases for mine lubrication should be the best obtainable.

THINGS TO WORRY GREASE MANUFACTURERS

In the various operations there are many applications that call for all the ingenuity at the command of the grease manufacturer, to make a grease to satisfactorily do the job.

Just to name a few at random we have the paddle wheels of the sintering machine. What is a sintering machine? Briefly, it is a machine that mixes fines from the ore mines, the dust from blast furnace gas and coke breeze, then fuses them together with a gas flame. This "sinter" partially burns as it is conveyed by a moving bed and finally dumped into a car at the end of the conveyor. The wheels of the conveyor are equipped with antifriction bearings and the grease used for their lubrication is exposed to both heat and dust.

Another application that tests the heart of a grease is the latch screw on coke oven doors. Where there are several batteries of coke ovens operating there are thousands of points of application. The longer a grease will stay in this very hot spot without coking, the happier the mechanical crew will be.

Then there are the bearings on the hot metal cars and ladles. The grease must combat weight and heat. Here, too, it is quite impossible to maintain a strict, regular schedule of greasing.

The approach and delivery tables of the various rolling mills provide another tough job for grease. Due to the fact that the red-hot slab or plate passes back and forth through the reversing mills, these bearings are constantly exposed to terrific heat and pressures. This is intensified when trouble develops in the line some place due to cobbles or mechanical or electrical trouble. The plates might rest on the tables for several minutes. This, of course, heats the bearing still more. Then there are water and mill scale to add to our troubles.

Hope I haven't discouraged you too much in case you are trying to develop an all purpose grease. Just want you to know there are no "panty-waist" jobs for greases in a steel mill.

A SALUTE TO THE PETROLEUM INDUSTRY

Of course it wouldn't be good manners on my part to visit you people without saying something nice about my hosts. It just so happens that I can do that without crossing my fingers. The problems confronting lubrication engineers in industry have been made much easier because of the fact that he has willing help available in the various oil company engineers. No doubt a lot of industries are not availing themselves of the service of these men. In my opinion this is a grave mistake. If you are laboring under the false impression that these men are merely salesmen and turn into mercenary vampires the minute you admit them to your plant, you are denying yourself some very valuable service. The majority of these men have had the advantage of technical training in petroleum engineering and in some cases practical experience.

Buying lubricants from oil companies without discussing your various problems with their engineers is like buying skimmed milk. You are missing the cream. Don't be reticent to show these people your operations. The more they know of the application, the better lubricant they can furnish. Yes, I know they are in the business to sell oils and grease, but along with the product they sell they give away some very valuable services.

And so from us to you, from industry to grease manufacturers and distributors, a nice big bouquet and sincere thanks for a job well done. All of us realize that modern mills would be impossible without the genius that is yours.

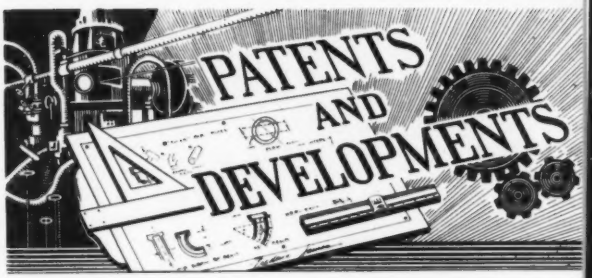
Thanks for asking me to visit; it's been a pleasure, and you must come to see us sometime.

* * *

WE HAVE BEEN ASKED . . .

Who drew that unusual background surrounding the picture of President-Elect Daniel that appeared on the cover page of the November Spokesman? ? ?

Here he is, the man who does most of our art work: Mr. Hubert Wilson. To him we owe considerable credit and praise for the noteworthy contribution his work made toward winning that 1949 Improvement Award.



TRANSPARENT REVERSIBLE GREASES—According to a recent patent issued to Standard Oil Development Co., improved thermally-stable transparent greases adapted for use in "lubricated-for-life" bearings, or under conditions where either high temperatures, water contamination or both are encountered, may be made by a technique involving use of mahogany sulfonates. Reversible greases are those grease compositions which can be heated to above their melting points and, upon being cooled, revert to their original consistency.

These greases comprise essentially a mineral lubricating oil and the reaction product of a salt of an oil-soluble sulfonic acid with a salt of another acid, wherein at least one of the metal ions is polyvalent. The presence of certain ions as impurities in the sulfonate solution tends to block the formation of the desired grease. For example, chloride ions must be removed or inactivated to obtain a satisfactory product.

In one example, a steam-jacketed scraped-wall grease kettle is charged with 3000 gms. of 30% concentrate of calcium sulfonate (about 900 molecular weight) and 3000 gms. of a 65 vis./210°F. naphthenic distillate oil. The concentrate and oil are blended by stirring or otherwise agitated at 180°-200°. When solution is complete, 164 gms. (dry basis) of calcium nitrate as an aqueous solution is added, emulsification taking place immediately. About 5 drops of silicon polymer are added to control foaming and the temperature is rapidly brought up to 250°-300°, when a grease structure starts to develop. Cold water is introduced into the jacket of the kettle to cool the product, and stirring is continued until the grease reaches a temperature of 100°, at which point it may be removed and packaged. A clear, bright grease which is completely water insoluble is obtained, having a melting point of about 260°-270°F.

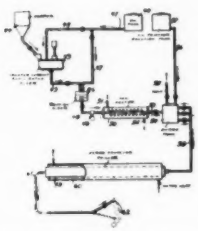
Other sulfonates which may be employed are those of sodium, potassium, lithium, barium, lead, copper, magnesium, nickel, iron, zinc, aluminum, di-2-ethylhexylamine, cyclohexylamine, and oleylamine. Besides nitrates and nitrites, one may use acetates, oxalates, formates, tartrates, succinates, citrates, propionates, lactates, glycolates, and malates (U. S. 2,483,800).

LOCOMOTIVE ROD CUP GREASE—A substantially anhydrous locomotive rod cup grease is described in a Sinclair Refining Co. patent. It involves a mineral oil component thickened by addition of a soda soap prepared by treating hydrogenated fish oil fatty acid with caustic soda. The mineral oil component consists of an extract obtained by the sufuric acid-nitrobenzene treatment of a Pennsylvania-type oil, this extract being cut back to a Saybolt Universal viscosity of about 400 seconds at 210°F., by the addition of Penn-

sylvania neutral oil, the ratio of soap to oil being 35%-45% soap and 64%-54% oil.

A preferred composition, in which a Pennsylvania neutral oil of 150 sec./100°F. is employed, has the following ingredients: soda soap 41.98%, free caustic 0.35%, mineral oil component 57.47%, water 0.20%, the composition having a penetration of 45-50 and a dropping point of about 380°F. (Can. 460,482).

CORROSION INHIBITOR—The use of an oil soluble arsine disulfide, such as n-butyl arsine disulfide is specified by a Shell Development patent as a corrosion inhibitor in lubricating compositions (Can. 460,479).



ALUMINUM SOAP GREASES—An aluminum base grease designed for the chassis parts of crawler-type tractors is described in a patent issued to Standard Oil Development Co. The process employed is illustrated in Figure 1 (Flowsheet for Aluminum Soap Grease Manufacture) and involves thoroughly mixing at a temperature of 280°-300°F. a mineral lubricating oil of 150-200 sec. Saybolt at 210°F. with 3-10% of aluminum stearate and 0.25%-1.5% of an alkylated mononuclear phenol, then rapidly cooling the heated mixture to a temperature below about 140°F. in a flowing stream and allowing the cooled mass to stand.

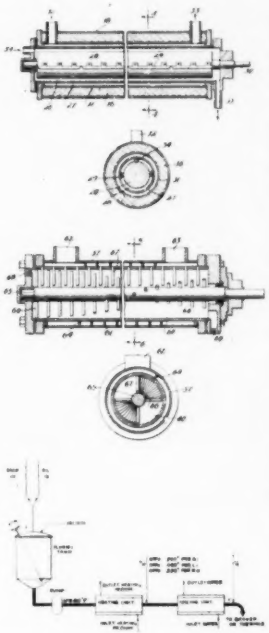
Rapid cooling is effected by passing through a helical screw scraper type cooling equipment in which the flow of the heated mixture is in the opposite direction to that of the motion of the screw and countercurrent to the flow of fluid in the cooling jacket. The preferred composition contains 0.75% phenol, 5% aluminum stearate, and 0.1% polybutene. The whole mixture is worked into a homogeneous mass having a worked penetration at 77°F. of about 325 (Can. 460,315).

PURIFICATION OF SULFONATES—A method of removing inorganic salt impurities from an oil solution having at least 20% oil soluble polyvalent metal sulfonates (made by double decomposition of alkali metal sulfonates and polyvalent metal compounds) involves treating the oil solution containing the reaction product of double decomposition, with an inorganic acidic material capable of forming water-insoluble salts with polyvalent metals, and filtering to remove the insoluble salts so formed (Standard Oil Development Co. U. S. 2,480,638).

HEAT STABILIZING MAHOGANY SULFONATES—Petroleum mahogany sulfonates are heat stabilized in presence of water by reacting a solution of the sulfonates in an organic solvent, with one of the following: water soluble inorganic and organic derivatives of hyposulfurous and sulfoxylic acid, by heating at 245°-255° for in excess of 120 hours (U. S. 2,486,373, L. Sonneborn Sons, Inc.).

SILICONE GREASE—Dow Chemical Co. obtained a patent on a lubricating grease composition consisting of a liquid silicone polymer containing monovalent hydrocarbon radicals attached to silicon as the only organic radicals, free from olefinic and acetylenic linkages, thickened to a grease consistency with up to 25% of carbon black (U. S. 2,486,674).

NEW ALUMINUM STEARATE—Witco Chemical Co. announced a new aluminum stearate (No. 22-G Grade) for the grease industry. It is said to possess extremely high gel characteristics and show less bleeding during storage. "Even extreme working of 100,000 strokes does not change penetration values appreciably from those obtained after 5,000 strokes" (Oil, Pt., & Drug Rep. 10-31-49, p. 55).



GREASE MANUFACTURE—A recent patent issued to The Girdler Corp. gives considerable data on the production of various greases, using the company's heater-cooler units of the type shown in Figure 2 (Girdler Heating or Cooling Unit), a cross-section of which is shown in Figure 3 (Cross-Section Taken at Right Angles to Figure 2), as well as the working unit shown in Figure 4 (Longitudinal Section of Girdler Working Unit), Figure 5 (Cross-section Taken at Right Angles to Figure 4) showing a section at right angles thereto. In the flowsheet shown in Figure 6 (Flowsheet of Girdler Process Showing Heater Outlet Temperatures), the approximate outlet heater temperatures for the different greases are indicated. The patent gives numerous heat transfer curves through films under varying operating conditions.

The important feature stressed is agitating the grease while simultaneously uniformly cooling it at a rate sufficiently rapid to lower the temperature of the grease through and substantially below the transition temperature and to substantially the critical temperature, before any substantial gelation of the grease can occur, the rate being in excess of ½°F. per sec. with an overall heat transfer coefficient of the cooling operation being at least 50 B.t.u./hour/square foot/°F., and then allowing the cooled grease to gel without appreciable agitation (U.S. 2,483,282).

FOREIGN PATENTS AND APPLICATIONS

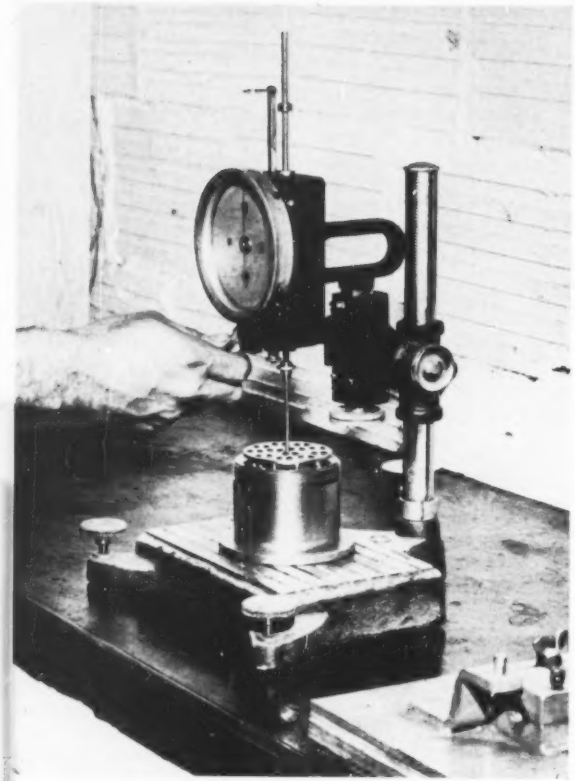
Brit. Pat. 628,878 (Dow Chem. Co.) Lubricating compositions comprising carbon black and organo-silicon oxide polymers.

Brit. Appl. 24741-3/49 (Stand. Oil Dev. Co.)—Lubricating grease compositions.

N. Z. 101,588 (Shell Oil)—Grease composition.

N. Z. 101,589 (Shell Oil)—Aerogel grease.

Can. 460,363 (Henderson)—Plate device for charging grease guns.



Controlling The Consistency Of Semi-Fluid Greases

by R. A. Potter and L. W. McLennan
Union Oil Company of California
Oleum, California

Last month we published an article by The Standard Oil Company on rating semi-fluid greases. Now, we are presenting a companionate article by The Union Oil Company which explains a different method.

I INTRODUCTION

The control of the consistency of semi-fluid greases is a problem of long standing. Many methods for the purpose have been examined but only several have proved to be moderately satisfactory. This paper presents a brief description of a method developed in an attempt to solve the problem in question. The method has proved its merit over a period of years not only in the manufacturing operations with which the authors have been associated but elsewhere as well. Certain features of the method are particularly attractive. Data are presented to show the range of usefulness of the test.

II THE PROBLEM

The problem of grading semi-fluid greases arises as one reaches the upper useful limit of the ASTM penetration range, namely about 375. At this point, the cone will displace its own volume of grease, if it is lowered carefully into the grease mass, and the grease will be on the verge of flowing over the side of and into the cone. Should the weight of the volume of grease displaced approach or exceed the weight of the cone, as might occur with some light-weight plastic or aluminum cones, then buoyancy or floating becomes an important factor. However, many greases are marketed which are much softer than this threshold value, namely about 375, and which still contain sufficient soap to impart a grease texture. It is principally for this class of grease that the subject test procedure is intended. It is not intended for those so-called fluid greases which are essentially mineral oils in composition because of the very low percentage of soap or additive which they contain. However, possibly it could be adapted for these latter greases.

Within the consistency range for semi-fluid greases, the soap content of the greases may vary considerably without the variation being reflected noticeably in the usual appearance of the grease. Furthermore, the viscosity of the mineral oil content of the greases may likewise vary without the variation being markedly evidenced. Another complicating factor less commonly encountered is aeration. Greases prepared with some heavy residual oils are especially troublesome in this respect. Therefore, in order that the test should function adequately, it should be reasonably sensitive to changes in composition and to changes in the viscosity of the mineral oil content. It should also be affected as little as possible by aeration and buoyancy.

III OTHER METHODS CONSIDERED

In an endeavor to find a method suitable for grading semi-fluid greases, many of the more familiar test procedures were investigated. A brief review of these follows:

1. A modification of the yield point-mobility procedure as described by Porter and Gruse[1] was employed for a period but was discarded eventually for several reasons. Principally, however, because as a control test, it was both complicated and time consuming.

2. The Stormer viscosity procedure, as well as some variations of it, was investigated. With this procedure, it was frequently found difficult to reproduce test values upon the same sample. This difficulty was explained in part by breakdown of the grease in handling or testing, and by channelling.

3. The McMichael viscometer was also examined and essentially the same objections existed here as for the Stormer viscometer.

4. An aluminum cone and shaft assembly, which weighed approximately 30 grams and represented the total falling mass for penetrating the grease, was employed for a short period. The corresponding assembly for the regular ASTM procedure weighs 150 grams. It was felt, however, that the buoyant effect at the higher readings was a considerable factor in respect to the inability to obtain sufficient and significant differences in readings on samples of widely differing compositions, particularly where the viscosity of the mineral oil content varied widely. A comprehensive analysis of the use of the light-weight cone for grading semi-fluid greases has been presented by L. C. Brunstrum[2].

5. A number of miscellaneous methods were also evaluated. These involved the use of manual grading by reference to standard samples, wooden cones, falling balls or rods, or a pressure viscometer. For rapid grading operations, none of these appeared to combine in convenient form the features of a desirable test method.

The foregoing methods, of course, do not exhaust the list of those that might be studied in connection with the problem but they are believed to represent the most promising ones used heretofore for the purpose[3]. Other methods for a generally similar purpose and used in the fields of paints, muds, starches, etc., are discussed in issues of the *Journal of Colloid Science*[4] pertaining to the subject of rheology.

The procedure involving the use of the familiar Gardner and S.I.L.[5] mobilometers was considered as the one offering the most favorable possibilities. The principle seemed sound inasmuch as a viscosity effect under a constant shearing force was being observed. However, with this test an additional piece of apparatus was required, which was moderately expensive, and for these reasons its adoption at this time did not seem warranted. Accordingly, the simple method employing a perforated disk in conjunction with the regular ASTM penetrometer was developed.

IV PERFORATED DISK METHOD

The perforated disk method as now used merely involves the use of a perforated disk instead of a cone in the regular ASTM penetration procedure D217-48. The disk is of the design shown in Figure 1, and it can be readily fabricated by any machine shop. In design, it consists of a perforated circular plate of steel with a thickness of ⅛ inch and a diameter of 2¾ inches, mounted on a ⅛-inch round shaft at right angles through the center. The shaft extends above the disk for 3 inches and below the disk for ¼ inch, tapering to a point. The perforations consist of three ½-inch holes in the disk equally spaced with their centers on the perimeter of a circle ⅜ inch in radius concentric with the shaft, and nine ½-inch holes equally spaced with their centers on the perimeter of a circle one inch in radius concentric with the shaft. The weight of this disk and attached shaft is approximately

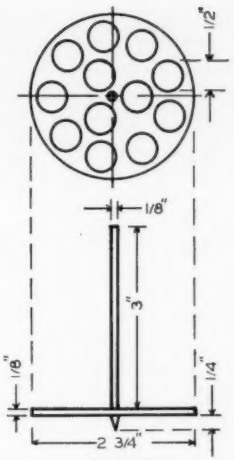


Figure 1
Diagram Showing Construction of Perforated Disk.

58 grams, as compared with a weight of 102.5 grams for the ASTM cone and its shaft. Its range of usefulness can be extended merely by using auxiliary loading weights in the same manner as that described for asphalt testing in ASTM procedure D5-25. The actual test procedure is similar to that for the regular ASTM penetration test, and hence it is already familiar to laboratory testing personnel.

In order to illustrate the flexibility of the test, a number of representative greases were prepared and tested. The data for the greases are presented in Table I and the penetration data are shown graphically in Figures 2-5 inclusive. It will be noted that sodium, calcium, lithium, and barium greases were tested and that their compositions are varied over wide limits within the range of consistency under discussion. In the case of the grease shown in Figure 5, it will be observed that several different added weights were used and, as was to be expected, some overlapping of the curves has resulted.

TABLE I
PROPERTIES OF THE VARIOUS GREASES PRIOR TO THEIR REDUCTION TO SEMI-FLUID GREASES†

Type of Grease	Soap, % by Wt.	ASTM Penetration at 77° F. (Worked)	Mineral Oil SUS at 100° F.	Texture
Sodium Base	12.0	337	1300‡	Short fibre
Calcium Base	20.4	220	220	Unctuous
Lithium Base	10.5	308	600	Unctuous
Barium Base	27.0	266	220	Unctuous

†Greases reduced with same oil as that used in their preparation to yield the greases shown in Figures 2-5 inclusive.

‡In the case of this grease, an oil of 25 V.I. and 600 SUS at 100° F. was added to portions of this sample in order to prepare the greases of lower soap contents shown in Figure 2.

In regard to some marginal greases which are very fluid and not frequently offered as semi-fluid greases, it might be found that the steel disk even without weights would be too heavy and would penetrate the grease too rapidly. This difficulty can be largely overcome for such marginal or special cases by use of smaller perforations or by the use of an aluminum disk instead of a steel one.

The advantages of using the perforated disk method will perhaps appear evident. Since it can be substituted directly for the ASTM cone on the ASTM penetrometer, no new skill is needed for its use. Also, because its passage through the grease depends upon the viscosity of the grease, the test result reflects changes in oil viscosity as well as changes in soap content. The test is relatively sensitive to changes in composition and this sensitivity permits a suitable range of values which in turn makes close control of production possible. Once the operator has determined the most suitable combination for his particular line of greases, he will be able to grade

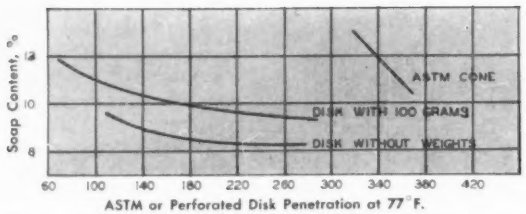


Figure 2—Showing Variation of Worked Penetration with Soap Content of a Sodium Base Grease of a Wheelbearing Type.

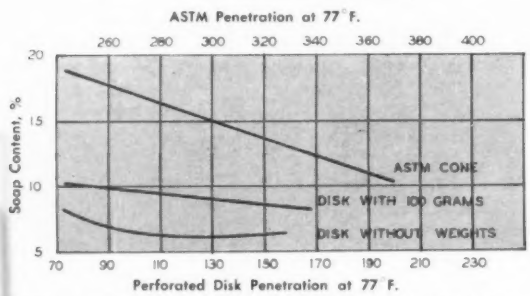


Figure 3—Showing Variation of Worked Penetration with Soap Content of a Typical Hydrated Calcium Base Grease.

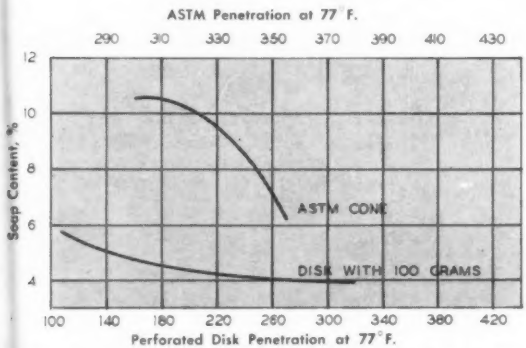


Figure 4—Showing Variation of Worked Penetration with Soap Content of a Lithium Base Grease.

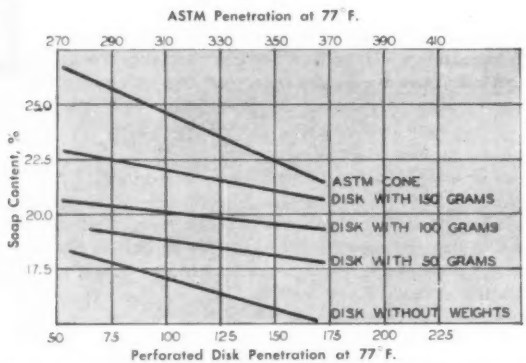


Figure 5—Showing Variation of Worked Penetration with Soap Content of a Barium Base Grease of an Unctuous Type.

his production of semi-fluid greases at least as readily and uniformly as he now does an NLGI 1 grade of grease with the regular ASTM cone.

Some semi-fluid greases containing residual oils are prone to aerate and thereby cause difficulties in grading during their production. In such cases the authors have found the perforated disk method more dependable than any other method which they have used.

The subject method has now been employed over a period of eight years for grading the commercial production of semi-fluid greases. Since its adoption, not only has close control of production been possible but previous complications, troublesome and expensive, have been eliminated.

It has been found that the repeatability of the proposed method, with one operator and apparatus, should involve a difference of not more than 10 units from the mean result, while the reproducibility, with different operators and apparatus, will be not more than 20 points difference from the mean result. These values are twice those stated by ASTM Method D217-48 for the Cone Penetration of Lubricating Grease. Also, it has been found that the penetration limits with the perforated disk for one grade of a semi-fluid grease should be about 60 units, as compared to 30 units for an NLGI grade tested with the ASTM cone, on the basis of comparative spread in manually-determined consistency and the relative degree of tolerance in the manufacture of each grade. It is logical that the number of penetration units used by the perforated disk to define the consistency of one grade of grease should be somewhat larger than the number required by the ASTM cone, since the disk provides less resistance against movement through the grease and consequently falls more rapidly.

It would appear from the authors' experience that a procedure based upon the principle embodied in the S.I.L. Mobilometer and in the perforated disk, offers definite advantages over other methods in grading semi-fluid greases. It is understood that a subsection of ASTM Technical Committee G is engaged in evaluating methods for testing the consistency of semi-fluid greases, and these methods will doubtless receive an exhaustive evaluation by the committee.

V SUMMARY

A description has been presented of a relatively simple and inexpensive test for measuring the consistency of semi-fluid greases. In the past, this problem has presented troublesome and expensive complications. The use of the perforated disk method appears to have provided a simple method for eliminating these difficulties for several laboratories. The description of the method and the results of its application are timely since the general problem is under review by the ASTM Technical Committee G.

ACKNOWLEDGMENT

The authors wish to acknowledge the generous assistance of Mr. E. J. Eifert in developing data for this paper.

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1. P. K. Porter and W. A. Gruse, "Measurement of Cup Grease Consistency by Use of Plastometer," *Ind. Eng. Chem.*, 17, 953 (1925).
2. L. C. Brunstrum "The Light-Weight Cone for Penetration of Soft Greases," *ASTM Bulletin No.* 154, October, 1948, p. 66.
3. For additional test procedures and discussion see "Lubricating Greases, Their Manufacture and Use" by E. N. Klemgard, 1937 Edition, p. 833 *et seq.*
4. *Journal of Colloid Science*, February, 1947, and June, 1949.
5. K. C. Combes, C. S. Ford and W. S. Schaer, "An Improved Mobilometer for Measuring Consistency of Fluid and Semi-Fluid Greases," *Ind. Eng. Chem.*, Anal. Ed. 12, 285 (1940).

ABOUT THE AUTHORS . . . OF CONTROLLING THE CONSISTENCY OF SEMI-FLUID GREASES

MR. L. W. McLENNAN

Mr. McLennan was born in Canada in 1900 and received his elementary and high school education in Vancouver, Canada. After completing his undergraduate work in chemistry, he graduated (B.A.) from the University of British Columbia in 1922. The following three years (1922-1925) were spent at Oxford University in England, doing graduate research work. After graduating in 1925 (B.Sci.), he became associated with the research group of the Koppers Co. in Pittsburgh, Pa., until 1927. During 1927-1928, Mr. McLennan held a teaching fellowship at the University of California. In 1928, he returned to industrial work with the Research Department of the Union Oil Co. of California and has been associated with this firm since that time.

During the past 21 years, he has dealt with almost every problem in the field of petroleum refining. For the past 18 years, much of his work has related to lubricating oil greases and the various aspects of their formulation, manufacture, and testing. At the present time, he directs the company's research laboratory at Oleum and in particular supervises research on greases. Probably the principal or major development in grease technology with which he has been intimately concerned has been the establishment of barium and strontium soap greases on a commercial basis. In both instances, he has participated in the development from the earliest stages to the realization of full commercial production. In addition to the foregoing, he is also very familiar with all types of lubricating greases currently marketed.

Mr. McLennan, as well as being a staunch supporter of the National Lubricating Grease Institute, is a supporter of various other scientific groups including the American Chemical Society and the A.S.T.M. His hardy support and interest in the N.L.G.I. resulted in his fellow members unanimously selecting him to serve on the Board of Directors.

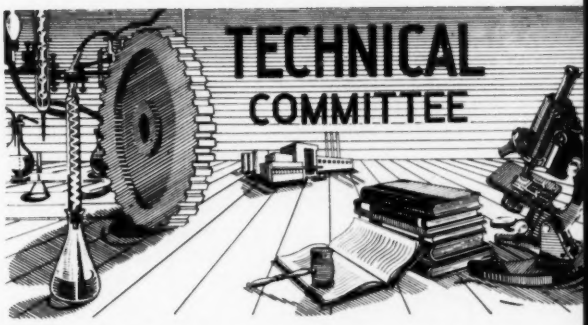
Apart from his research activities, his principal interests are in gardening, the theatre, and foreign affairs.

MR. RALPH A. POTTER

Mr. Potter was born in Kansas in 1902 and received his elementary and high school education in Chandler, Oklahoma, in Milwaukee, Wisconsin, and in Spokane, Washington. He took a business course at the Blair Business College in Spokane and obtained a B.S. degree in chemical engineering at Oklahoma A. & M. College, as well as an M.A. degree in education at the Berkeley Baptist Divinity School in Berkeley, California.

During the past 21 years in the research department of the Union Oil Company of California he has been concerned with various problems of petroleum refining, particularly in regard to the development or improvement of various lubricating greases and oils. As a group leader in research, he has assisted in developing new testing methods, establishing specifications and initiating the commercial production of new or revised products. He is a member of the American Chemical Society and interested in cooperative testing work for A.S.T.M. and other societies.

Mr. Potter is married and has two sons and a daughter in college. His principal hobbies are church and Boy Scout activities, as well as home building and landscaping.



Chairman T. G. Roehner, Director of the Technical Service Department, Socony-Vacuum Laboratories

It will be recalled that due to lack of time at the New Orleans Meeting there was very little discussion of the papers read by Mr. J. Musselman, of the Standard Oil Company (Ohio), and Mr. W. R. Power, of Cities Service Oil Company, introducing the subject of "Changes of Unworked and Worked Penetrations of Greases in Storage." This item was placed on the agenda because of the number of requests received from the membership. Presumably it was regarded as important to the producer and consumer. Mr. Power opened his presentation with the following paragraphs:

"All of the common types of lubricating greases are subjected to a penetration or consistency test shortly after their manufacture. This test is one of the guides in grease making, and as such must be run as soon as possible to be of the maximum value to the grease maker. Unfortunately, however, this initial penetration does not always remain fixed and greases sometimes will soften in storage, or, less frequently, will harden in storage.

"For the purpose of this discussion a change of ten points or less, due to the vagaries of the test procedure, has not been considered significant. Therefore, when it was stated previously that certain greases softened or hardened in storage you can see what a change of more than ten points was involved. To be more specific, these variations occur to our knowledge in sodium base, calcium base, aluminum base, and mixed base greases. The variations may likewise occur in any of the N.L.G.I. classifications, but they seem to be more prevalent in the heavier types. It is not uncommon to find a 20, 30, or even 40 point change in the 60 stroke or the 10,000 stroke worked penetration after two weeks storage. One of the most disturbing features of this variation is that the great majority of the grease batches remain unchanged in storage and only occasional batches have this unpredictable change in penetration.

"From a service standpoint it is recognized that this consistency variation is usually of very little significance. In some cases, however, a customer has certain consistency specifications which he insists be met, and rejection or dissatisfaction can occur if this customer finds by testing that the shipment which was on test at the point of manufacture is off test on delivery."

Mr. Musselman's comments differed somewhat from the above, but essentially the same point was made, namely, that changes in penetration would occur during storage of the

greases and the extent of these changes were not always predictable. In other discussions of this subject since it first appeared on the 1948 agenda, a number of interesting opinions were discussed.

I The tolerance of bearings in service so far as penetrations are concerned is generally quite broad because if it were otherwise more troubles would have been encountered. It was recognized that there are exceptions.

II Narrow ranges of penetrations per grade may have little justification from a practical significance viewpoint except for the specialized applications.

III These observations appear to tie in with the use of multi-purpose greases, the adoption of which is partly based on a compromise of penetration range requirements.

The above are just three of a number of opinions expressed. We are ready to carry on the discussion by using this column as a medium for relaying any comments forwarded to the writer.

Books and Publications

. . . About the Industry

LABORATORY MANUAL OF GAS, OIL AND FUEL ANALYSIS

By Carl J. Engelder. Second edition in preparation. A working guide to the best methods of analysis.

THEORY OF LUBRICATION

By Mayo D. Hersey, Research Associate in Mechanical Engineering, Massachusetts Institute of Technology. Second edition in preparation.

A complete account of the present state of the theoretical development of the science of lubrication. Emphasis throughout is placed on the physical rather than the mathematical side.

FUNDAMENTALS OF DIESEL ENGINES

A publication released by the U. S. Navy entitled, "Fundamentals of Diesel Engines," can be ordered at a cost of $1.50 through your field office. The main purpose of this book is to serve as a text in diesel schools preparing diesel engineering officers and diesel engine service men. It gives basic principles of diesel engines, engine construction, engine performance, structural engine parts, fuel injection, bearing lubrication, engine mechanics, and engine controls. 1947. 136 pages, illustrated.

Greasonalities

SWIFT & COMPANY

Transfer from Chicago to Hammond, Indiana, of the administrative offices of the Industrial Oil Division of Swift & Company has been announced by F. E. Lacey, manager. The move will be completed about January 1.

Included in the transfer will be the executive personnel, raw material buying, sales representatives and clerical staff.

At the present time, administrative offices for the Industrial Oil Division are in the Chicago General office of Swift. The company recently built a modern, integrated fractionation and decolorization plant at Hammond as part of a proposed technical products group. Administrative offices are provided in the plant.

The new office address will be Swift & Company, Technical Products Plant, 165th Street and Indianapolis Blvd., Hammond, Indiana.

CITIES SERVICE OIL CO. (Del.)

Edward L. Stauffer has been named assistant to Wm. H. Merritt of Chicago, vice-president of Cities Service Oil Co. (Del.) and manager of its Marketing Division, according to an announcement by A. W. Ambrose of Bartlesville, president of the company.

Stauffer, also headquartered in Chicago, was promoted from the position of chief engineer and superintendent of operations in charge of the company's marketing properties. A long-time Cities Service employee, he was first assigned to the junior engineer training program of the company and held positions in all phases of its integrated operations. He obtained broad experience in natural gasoline operations, production, refining, chemical manufacture, pipeline and general engineering and construction before becoming superintendent of the company's natural gasoline division.

ESSO STANDARD AND AFFILIATES

Well represented at the N.L.G.I. 17th annual meeting was Esso Standard Oil Company of Pennsylvania and affiliates. They had 26 representatives which are as follows: Carter Oil Co., Don A. Duling, W. K. Randall; Esso Standard Oil Company, A. T. Ambrose, Alan Beerbower, M. E. Beige, H. E. Bloomsburg, F. D. Broussard, A. E. Calkins, C. R. Daniels, R. E. Darley, L. C. Dawson, C. B. Karns, G. M. McNulty, J. V. Schen, W. H. White; Humble Oil & Refining Co., B. P. Robertson, Guy Roxburgh; Imperial Oil Limited, H. H. Wilson; Penola, Inc., C. B: Baily, W. H. Bower; Standard Oil Development Company, K. C. Combes, J. J. Kolfenbach, Charles Leaver, H. L. Leland, A. J. Morway; Standard Oil Co. (New Jersey), D. C. Sandy.

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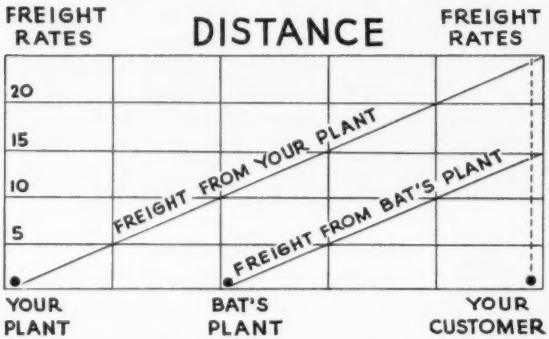

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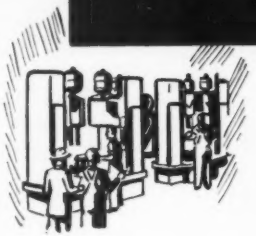

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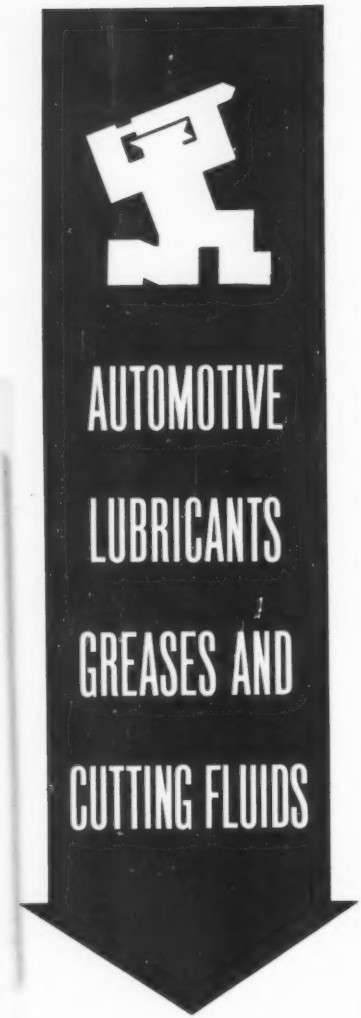

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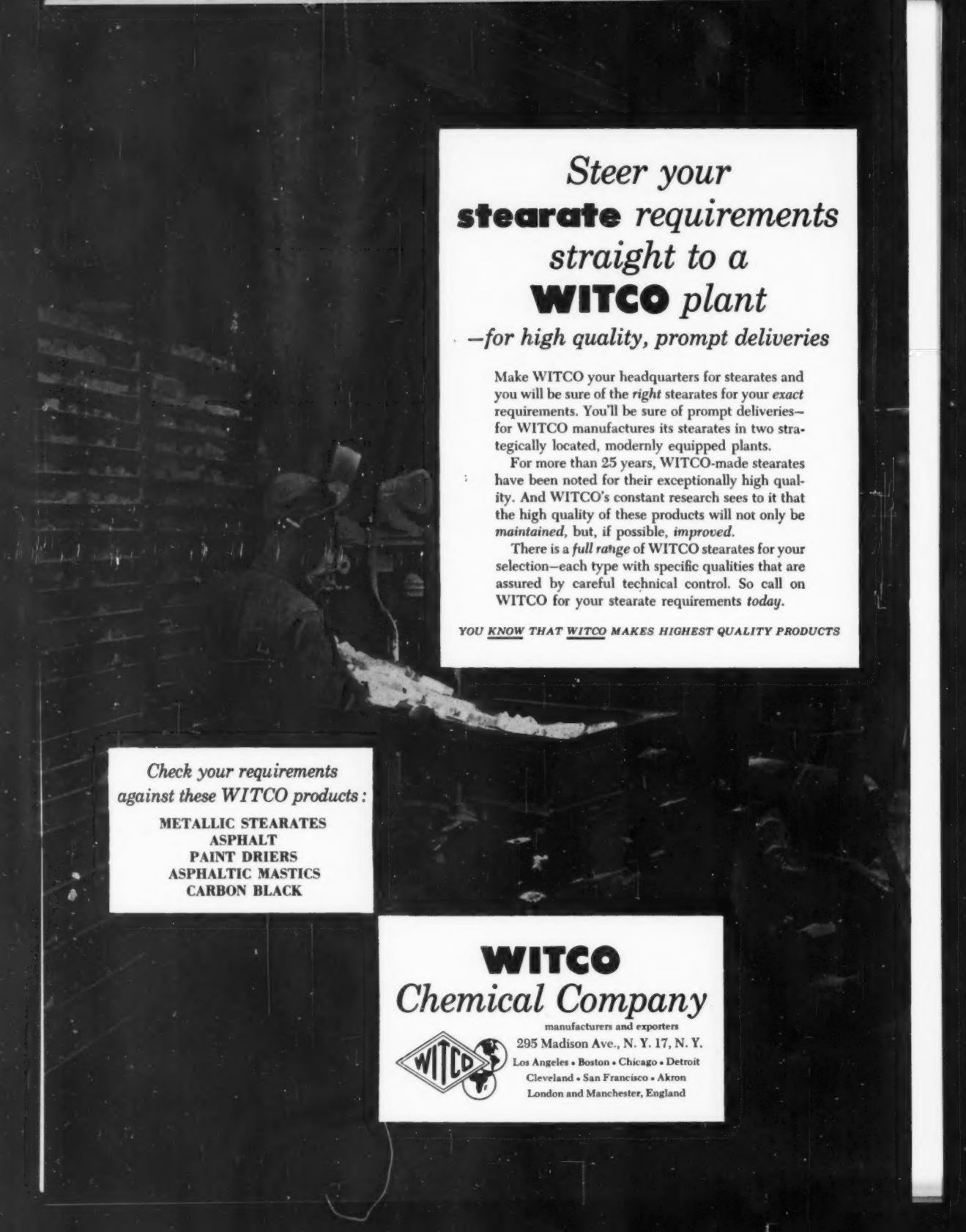

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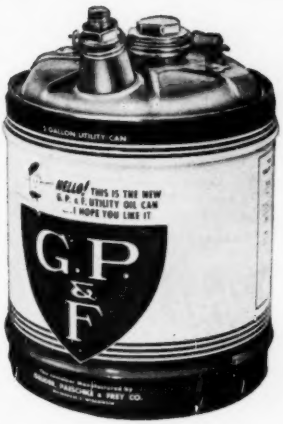

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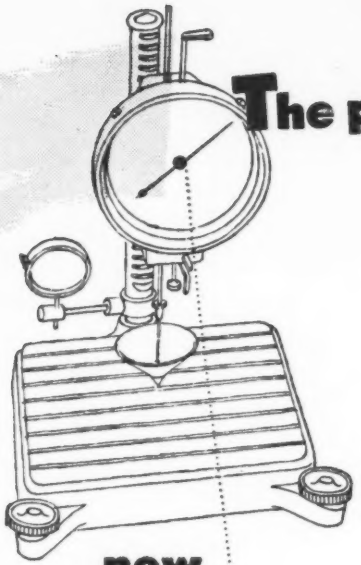

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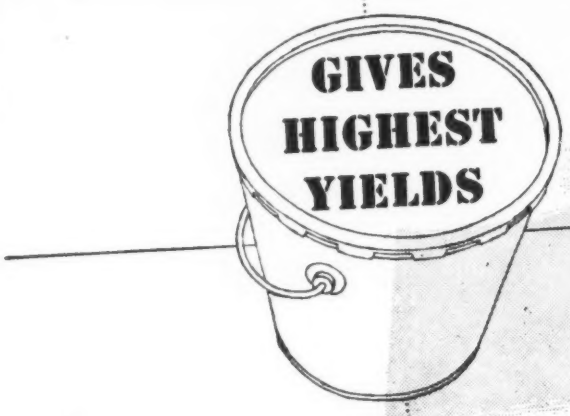

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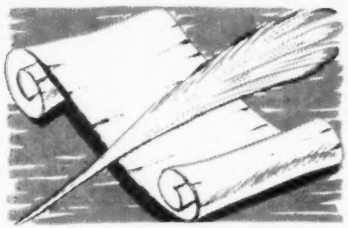

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Balcrank, Inc.
Disney near Marburg
Cincinnati 9, Ohio
Member—R. P. Field

The Fil-Rite Company
342 Lumber Exchange Building
Minneapolis, Minnesota
Member—Howard G. Hornibrook

Gray Company, Inc.
60 11th Avenue Northeast
Minneapolis 13, Minnesota
Member—L. L. Gray

Lincoln Engineering Company
5730 Natural Bridge Avenue
St. Louis, Missouri
Member—Foster Holmes

National Sales, Inc.
812 North Main Street
Wichita, Kansas

Stewart-Warner Corp.
1826-1852 Diversey Parkway
Chicago, Illinois
Member—Walter Duncan

U. S. Air Compressor Company
5300 Harvard
Cleveland, Ohio
Member—F. J. Coughlin

LABORATORY EQUIPMENT AND SUPPLIES

Precision Scientific Company
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Chicago 47, Illinois
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Buffalo 15, New York
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Cornell Machine Company
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New York City 17, New York
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The Girdler Corp.
Louisville 1, Kentucky
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